MULTIMEDIA UNIVERSITY

STUDENT ID NO

TABLE NO: _____

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

TCP2101 – ALGORITHM DESIGN AND ANALYSIS / TCS3211 – ALGORITHM ANALYSIS

(All Sections / Groups)

15 OCTOBER 2016
2.30 p. m. – 4.30 p. m.
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 11 pages with 4 Questions only.
2. Answer all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in **this Question paper**.

Question 1

a) An algorithm **XYZ** is provided below.

i) Fill in the column named Number of Primitive Operations, and find the time complexity of the algorithm in big-O notation. [4 marks]

Algorithm XYZ (A, S, n) Input: Array A of n ≥ 1 integers Output: Array S	Number of Primitive Operations in Big-O notation
S[0] ← A[0]	
for i←1 to n-1 do	
S[i] ← A[0]	
for j←1 to i do	
if A[j] < S[i]	
S[i] ← A[j]	
T(n)	

ii) Use the XYZ algorithm above, fill the value of $S[i]$ into the table below. [3 marks]

i	0	1	2	3	4	5
A[i]	12	7	4	9	1	8
S[i]						

iii) What does array S contain at the end of algorithm XYZ? [2 marks]

Continued...

iv) The XYZ algorithm can be improved in term of time complexity. Write an **improved** version of the XYZ algorithm. You may start with the following two lines. [4 marks]

```
S[0] ← A[0]
for i←1 to n-1 do
```

b) The following sequence of integers is provided.

```
21 33 81 70 10 11
```

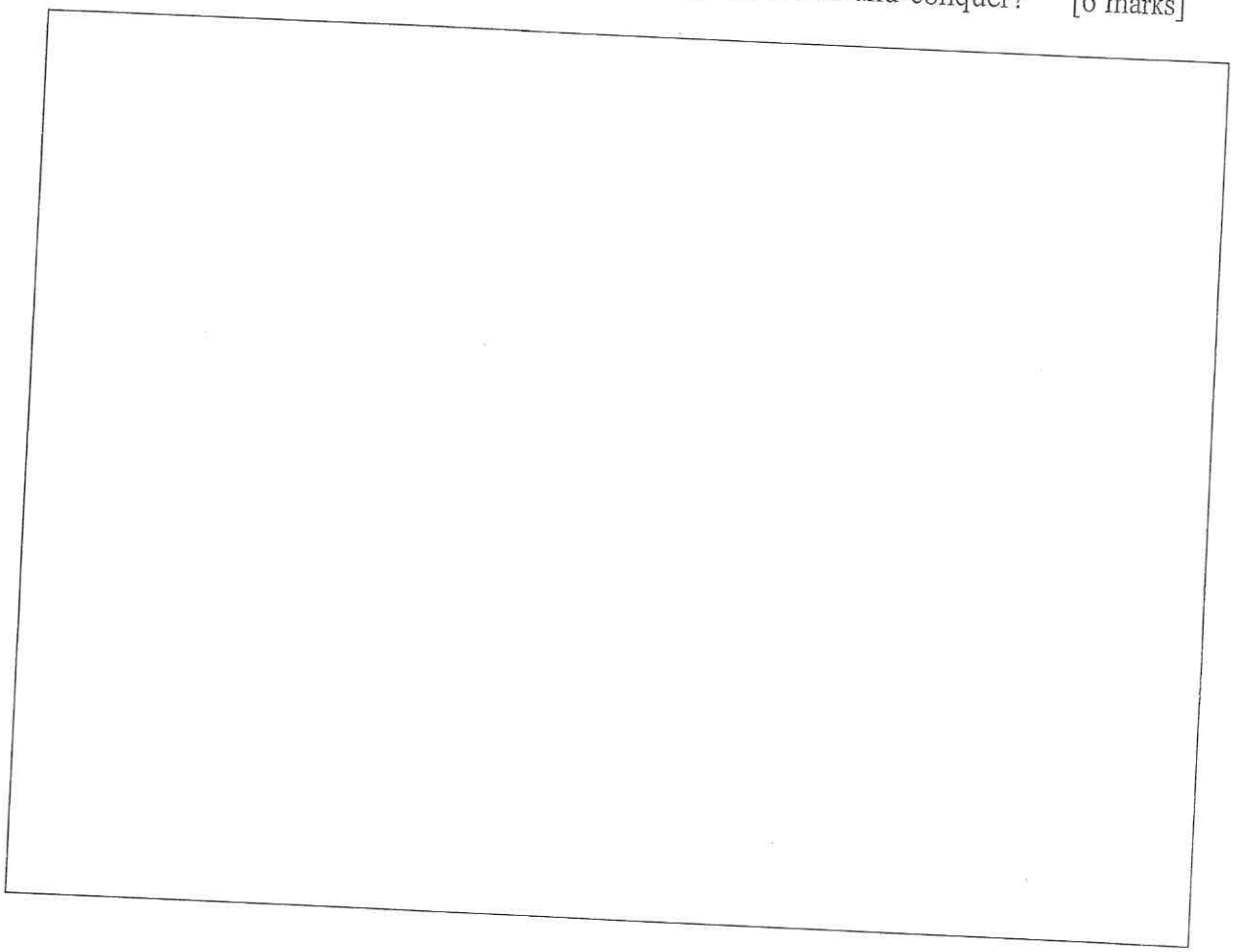
Find out the **hash values** of the above sequence using the following hash function.

```
h(k) = k % 11
```

Create a hash table for the above sequence. Use **chaining** to resolve collision. [6 marks]

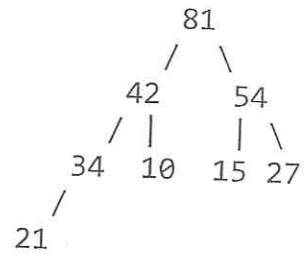
Continued...

c) Name TWO algorithms that are based on dynamic programming approach. What are the key **differences** between dynamic programming and divide-and-conquer? [6 marks]



Question 2

a) The following heap is provided. **Dequeue** the heap **4 times**. Show the **intermediate results** (steps) for each dequeue. [8 marks]



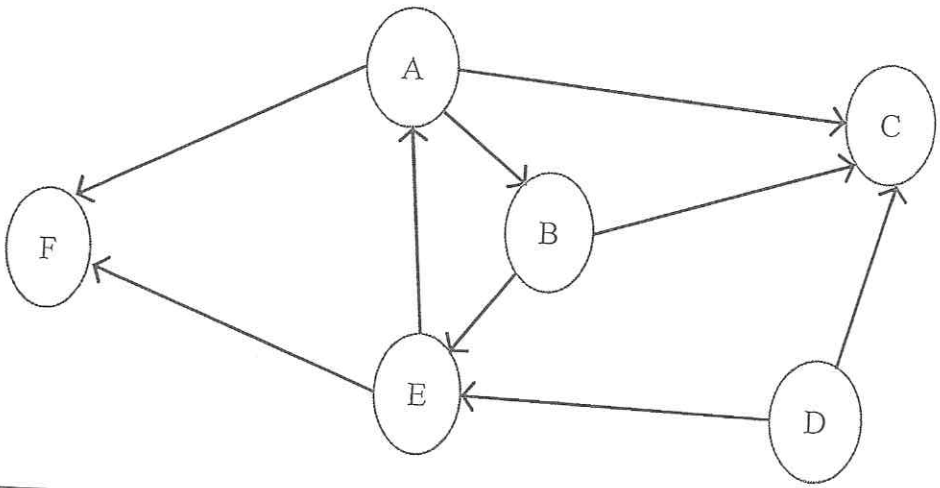
Continued...

b) A graph can be represented as an adjacency list or an adjacency matrix. Which representation **uses more space** in representing a **sparse** graph? **Explain** your answer. What are the **space complexities** of an adjacency list and an adjacency matrix respectively for a sparse graph?

[4 marks]

c) Draw an adjacency matrix for the graph below.

[6 marks]



Continued...

d) A Binary Search Tree (BST) can be traversed using pre-order traversal, in-order traversal, or post-order traversal. Complete the `preOrder` traversal algorithm below. [3 marks]

```
Algorithm preOrder(v) {

}
```

e) The following sequence of numbers is provided.

```
10 54 24 60 72 81
```

Construct a **binary search tree** (BST) based on the above sequence. Is the BST **balanced**? [4 marks]

Continued...

Question 3

a) **Explain** briefly the **TWO phases** involved in the **bucket-sort**. State the **time complexity** (in big-O) for each phase.

[6 marks]

b) Show in **steps** (intermediate results) how **quick-select** algorithm finds the 3rd smallest element in the array S = {12, 3, 6, 5, 4, 10, 11, 7}. For every partition step in quick-select, select the **last element** as the pivot.

[6 marks]

Continued...

c) Use Master Theorem to find the time complexity (in big-O) for the following two equations. The three cases of Master method are shown below: [6 marks]

i. $T(n) = 4T(n\text{-}3) + n$

ii. $T(n) = 8T(n/2) + \text{n} \log^3 n$

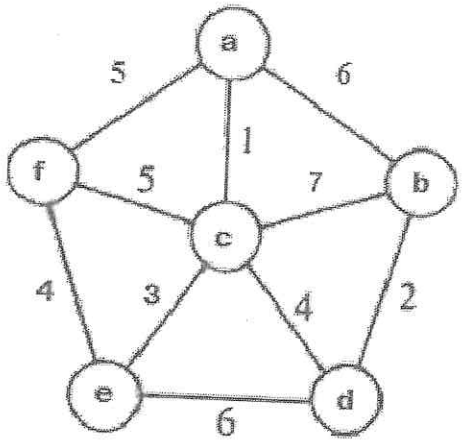
The Master Theorem:

1. if $f(n)$ is $O(n^{\log_b a - \varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a} \log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a} \log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a + \varepsilon})$, then $T(n)$ is $\Theta(f(n))$, provided $af(n/b) \leq \delta f(n)$ for some $\delta < 1$.

Continued...

d) Use **Prim Jarnik's** algorithm to find the minimum spanning tree for the following graph. The start vertex is *a*. Show the **intermediate steps** in your answer. What is the **total weight** for this MST?

[7 marks]



Continued...

Question 4

a) Use **Selection-Sort** to sort the following numbers. Write down the **intermediate results**. What are the **best case and worst case time complexities** of Selection-sort? Is Selection-sort is **faster or slower** than Heap-sort? What are the **best case and worst case time complexities** of Heap-sort? [11 marks]

66 11 22 77 44 55 33

b) Explain briefly the two complexity classes, i.e. P and NP. [4 marks]

Continued...

c) The following table has five products; each shows its weight and benefit. Use **0/1 knapsack algorithm** to choose products with maximum total benefit but with the weight at most **9** kg. List the **selected items** and state the **maximum total benefit**. [10 marks]

Product	A	B	C	D	E
Weight	4 kg	2 kg	2 kg	6 kg	2 kg
Benefit	$20	$3	$6	$25	$80

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